CALFED BAY-DELTA PROGRAM

Office Memorandum

Date: October 2, 1995

To: CALFED Staff

From: Michael Norris

Subject: Summary memo for Bay Delta Modeling Forum Statewide Reservoir Operations Models at the Secretary of State Building Auditorium in Sacramento on 9-21-95 and 9-22-95

I attended a Bay Delta Modeling Forum (BDMF) conference on 9-21 and 9-22-95 at the Secretary of State Building Auditorium in Sacramento. This was the sixth of possibly a dozen workshops that will be conducted by BDMF. The conference was well attended and the subject matter on reservoir operation models proved to be quite interesting. There were a number of key speakers from DWR and USBR. An agenda and some handouts are attached. The agenda was stuck to except that the individual presentation on "Other DWRSIM new enhancements in progress" by Sushil Arora and Bill Smith was deferred to a future date. A summarization of the material presented by each speaker follows below.

PRESENTATION ON DAY ONE 9-21-95:

1. **George Barnes, DWR & Dan Sheer, WRMI**

Barnes led the introduction with an overview of operation models and then turned over the first presentation to Dan Sheer from the consulting firm of Water Resources Management Inc (WRMI). Sheer specializes in state of the art water resources simulation models and began the presentation by discussing how model classes can be divided into research models and management models. According to Sheer, research models are generally designed to figure out the way the real world works and management models are designed to test the "what if" scenario assuming one already knows how the real world works. Sheer discusses how management models can be divided further into Planning Models that examine long term performance and Operations Models that are prescriptive models that examine short-term performance such as the Central Valley Project and State Water Project (CVP/SWP) operations. Sheer stressed that the objectives for models are that they give the most accurate evaluation and are easy to use and that management models are the basis for regulation. Sheer discussed the model time step. It is best to take the largest time step that adequately describes the system and changing the time step requires changing the operating rules. It was also discussed that physical alternatives and operations policy are described in the input data base. Operations policy often take on the form of standard forms such as rule curves and minimum flows. Lastly, the "optimization" feature was introduced as it applies to Planning where long-term deterministic optimization (LDO) is done as opposed to Operations where single, multiple, or stochastic dynamic programming are

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done.

2. **Jeff Lefkoff, Hydrologic Consultants Inc**

HCI consultant Lefkoff discussed optimization routines. The linear technique is one method discussed by Lefkoff such as an x-y graph where one is looking for a solution that meets demand and some other limitation such as the ability to generate electricity to move the water. An example was presented where the Folsom South Canal was extended to bypass the pumps and supply water directly to the users. Graphs were shown illustrating the use of the optimization model and the increase in water supply deliveries that results over the base delivery. Lefkoff noted that the use of stochastic-dynamic programming in optimization modeling is probably 10 years away from being developed for use.

3. **Lenore Thomas, US Bureau of Reclamation**

Thomas and co-workers Peggy Manza and Huxley Madeheim discussed the San Joaquin River model which is known as "SANJASM". An overview of San Joaquin hydrology was given. It was noted that the average annual precipitation is 13 inches. Also, most land generating inflow is on Sierra slopes under public ownership and is thus unlikely to be impacted by future development. Thomas noted that SANJASM is a planning tool used for New Melones and Friant reservoirs, for water quality concerns and requirements, and to gauge the effect of non-federal projects and diversions. SANJASM models drainage on the east side of the basin only and the drainage from the west comes from input data. SANJASM has a monthly time step, is customized for reservoir operations and surface accounting, has separate accounting for agricultural and M&I diversions as well as project and non-project (riparian) users, and is set up to maximize diversions while maintaining minimum stream flows. Input data requirements for SANJASM include such things as reservoir inflow and operating criteria, total gains, and west side return flows. Available output includes reservoir operations, stream flows, diversions, and water quality at Vernallis and New Melones. Recent enhancements to SANJASM include such things as revised water quality computations to consider west side return and tributary flows independently and processors for New Melones releases to help the model meet new delta water quality standards.

4. **Derick Hilts, US Bureau of Reclamation**

Hilts discussed the project simulation model known as PROSIM. He showed a schematic of the model and showed various input and output files and programs. An example of a balance sheet output file was shown that is called BALSHEET. BALSHEET gives detailed information on a nodal basis. Other files were shown such as ANNSUM (annual summary), a one variable file called ONEVAR (which includes options such as the "X2" position), and POWER which gives CVP output power. The computational process for PROSIM is such that it uses the month of March to make up its mind about what to do for the rest of the year. This is because by the start of March, one has a fairly good idea about what type of a water year it will be. PROSIM does a north-of-the-delta simulation initially and then a CVP/SWP southern delta simulation and then simulates the delta to meet all the various requirements. According to Hilts, it is difficult to compare DWRSIM and PROSIM although both are monthly run models. Average and critical-period-averages were compared for PROSIM vs. DWRSIM. The two models were within 5% of one another for the 71-year period of 1922-1992. The two models do not balance for pluses and

minuses; PROSIM produced wetter years on the average which is still a mystery to Hilts who expected some sort of a balancing to occur. Also, two simulations were done for DWRSIM for existing conditions vs. conditions after the 12-15-94 Delta Accord and these were called the "272B" and "409" runs, respectively. The USBR equivalents of these two runs on PROSIM were called the "551A3" and "554C2" runs, respectively. The two simulations compared favorably with one another. Hilts says the biggest enhancement planned for PROSIM is to change the time step from monthly to daily.

5. **Russ Brown, Jones and Stokes**

Brown says we need parallel management of delta water and fish resources. He says we can't work with just "available water forecasts" and "water supply targets" but these must be integrated with "fish habitat projections" and "fish population targets" too. Also, Brown says we are over constraining our models by putting in parameters like in-stream flows which end up depleting reservoirs thus making it hard to run the model. Various graphs were shown for various runs including one for the Delta X2 position and the resulting Delta outflow adjustment. Brown said the work was part of the Delta Wetlands Project EIR/EIS. Brown tends to emphasize daily analyses for modeling.

6. **Lloyd Peterson, US Bureau of Reclamation**

Peterson discussed monthly forecasting and his primary goal is to see how San Luis Reservoir operates. Models are run for the following 12 months. The model is a LOTUS spreadsheet for various reservoirs where inflows and demands are modeled. Peterson is concerned with making it through August of every year and still having some water left in San Luis and he relies on the spreadsheet to carefully estimate the demands to achieve that. Some agricultural users in the past have used 98% of the water available to them by the end of August.

PRESENTATION ON DAY TWO 9-22-95:

1. **George Barnes, DWR & Sushil Arora, DWR**

Barnes led the introduction by explaining that DWRSIM has been widely used in the past. It's use includes being used as part of the State Water Resources Control Board (SWRCB) water rights hearing process. It is also expected to be used in the near future as part of the CALFED Bay Delta Program process. Arora showed a diagram of the major features of the water projects in California and gave an overview of DWRSIM. Arora says DWRSIM simulates the operation of CVP/SWP, has a monthly time step, uses a 71-year study period from 1922-1992, uses Bulletin 160 values to reflect land use, is "pre-operated" for the San Joaquin system (except for Stanislaus and New Melones), and the application of the model is in the "comparative" mode to reflect "with vs. without" scenarios to estimate impacts. However, some key elements to the Governor's Water Policy add some new phases to DWRSIM. Included in the governor's policy are objectives such as fixing the Delta, adding water for fish and wildlife, adding storage facilities, reducing ground water overdraft, water marketing and transfers, water conservation, Colorado River water banking, and others. As a result, enhancement of DWRSIM is sought. Arora says some enhancements include the ability to operate non-CVP/SWP water systems, the ability to incorporate evolving water management options, more detailed and accurate accounting of CVP, SWP, and Delta operations, the ability to improve model

input/output access through data management systems, improving the availability of the model and its documentation, and developing a more efficient, flexible, and state-of-the-art simulation model. To achieve these ends, Arora sent out a survey of "DWRSIM Model Users Needs" to CALFED, Contra Costa Water District (CCWD), SWRCB, DWR, the State Water Contractors, EPA, USBR, Metropolitan Water District (MWD), and the Environmental Defense Fund. The results of the survey indicate needs (listed in order of priority) including refining the carriage water component, Sacramento basin conjunctive use, expanding the San Joaquin River system, CVP/SWP one-system operation, water transfers from the Sacramento Basin, front-end and back-end utilities, real-time SWP/CVP delivery deficiency, isolated delta transfer, the development of a shorter time step logic, stochastic hydrology input, and others as well. Arora hopes to see some of the enhancements ready in two to three months although some features are ready now. Other features are still on the "wish list".

2. **Bill Smith, DWR**

Smith deals with input/output systems. The existing system is slated to be changed and the Corps of Engineers "DSS" system was selected as the new one. The new system, although more user friendly, will result in much more longer run times and has larger disk space requirements. The new input/output menu was designed by private consultant David Ford.

3. **Susan Lee, DWR**

Lee discussed that "X2" requirements require contributions of water from the San Joaquin system so there is a need to merge the STANSIM and DWRSIM models. The purpose of the merge would be to link the X2 position with the X2 flow requirement on the San Joaquin River.

4. **Robert Leaf, DWR**

Leaf discussed Annual Systems Delivery Logic". The annual delivery is what is being promised and can be shown on a "delivery-carryover risk curve". The problem is that the method can't handle export limitations after the 12-15-94 Delta Accord. In addition, the method uses "perfect foresight" which is unrealistic. After the 12-15-94 Delta Accord, it was decided to use the "fixed delivery mode" method which uses a delivery year of March-February, has the delivery level set by the user each month, and has a shortage elimination mode. The new decision timetable is such that a tentative delivery decision is made on 1-1 of a year, a commitment to delivery decision is made on 3-1 of a year, and the carryover storage is decided on 10-1 of a year.

5. **Ines Ferreira, WRMI**

Ferreira discussed the new engine that was developed by private consultant David Ford for DWRSIM. The engine drives the simulation and ensures physical integrity of water flows through the system through routing and mass balance. The system is set up so that the initial constraints are identified, the engine then runs the simulation, and a check is made of external constraints. This type of format allows one to put in a new engine down the road without disrupting the system. Ferreira discussed the existing engines for CVP/SWP planning models. The PROSIM engine is a custom written engine from upstream to downstream for the entire system. The DWRSIM engine is actually two engines. The network flow is an "OKA" engine

for the south of the delta operations and the other engine is a customized HEC3 for the north of the delta reservoir operations. The problem is that HEC3, although widely used, was not written to deal with the complexities of the California water supply system. There are other shortcomings with the present engine. The code for DWRSIM which has become involved and difficult to maintain. The ability to evaluate new management alternatives has become time consuming and expensive. Also, a custom engine requires program modifications to make changes. Ferreira notes that a standard method for the engine is desirable because of computational efficiency, a reduction in cost of program development, its ease of replacement with a more efficient algorithm when it becomes available, and a standard method providing a convenient standard for describing the system. Engines considered included the OKA (network algorithms), a network with side constraints, linear programming, mixed integer linear programming, dynamic programming, and non linear programming. The engine that was picked was the mixed integer linear programming type and it was selected because it provides flexibility by offering a "yes-no" situation, can be almost completely data driven, is not bound by any specific input/output format, has efficient algorithms, and was available at a reasonable cost. The new engine will be tentatively available 12-95.

6. **Susan Lee, DWR**

Lee discussed that the purpose of delta transfer enhancements is to model the operation of a delta transfer facility and to model the operation of an in-delta storage facility. The proposed peripheral canal and the proposed Delta Wetlands Project were respective examples of these and figures from reports were shown as well as a new network schematic for DWRSIM with the proposed delta transfer enhancements in place. Its use has not yet been implemented because it is not known what the rules of operation of these types of facilities would be.

7. **Devinder Sandhu, DWR**

Sandhu discussed modeling of a joint reach concept which is a shared CVP/SWP use along the California Aqueduct such as an expanded joint reach of the aqueduct, an expanded Delta Mendota Canal, and an expanded South Bay Aqueduct. There is available CVP capacity for SWP use when the SWP share of the aqueduct is full. By modeling the joint reach, one can get benefits such as joint reach sharing and CVP deliveries by type. At present, there are no rules on how to operate the proposed joint use facilities.

8. **Ralph Finch, DWR**

Finch discussed artificial neural networks (ANNs) as they relate to carriage water (ie the amount of water above an increased export so as not to increase salinity in the Delta) in DWRSIM. ANNs are nonlinear black box modeling systems used for interpolation of the existing system whereas the Delta Simulation Model (DSM) is used for extrapolation from the existing system to the planned system. ANNs will return salinity at a location given current and previous months Sacramento and rim flows. The objective is to minimize the volumes of Sacramento flows over some time period while meeting all salinity requirements. At present, only simple "ramping up" to the salinity requirement is done where abrupt changes in salinity are avoided by ramping up to the standard several days in advance. The use of ANNs can avoid this process. Although ANNS do not explicitly calculate carriage water, when a final Sacramento flow is computed, one more call is made to the ANN with the exports set to zero. The difference

can be used to determine the carriage water.

9. **Tariq Kadir, DWR**

Kadir discussed linking the hydrology model with DWRSIM. At present, hydrology is developed by running the consumptive use (CU), depletion analysis (DA), and COMP models in respective order. The CU model provides estimated historical water use and projected water requirements by month for use as input to the DA program and maintains a soil water budget and calculates the allocation of water use by plants from rainfall, stored soil moisture, and irrigation. If one wants to take certain crops out of production for example, one has to first go through the CU, DA, and COMP model runs using the output of each model as input for the next model before one can see the benefits (ie more water) of the reduced crop acreage using DWRSIM. The new "CUDACOMP" model automates the process. Two sample runs exist at present for the years 1995 and 2020. In addition, CUDACOMP seeks to improve the hydrology development by extending the 71-year 1922 to 1992 period through 1994, modifying the land use projections as they appear in Bulletin 160, and improving the simulation of existing systems (ie HEC3). At this point, the model is essentially untested except for the sample runs. Kadir did note that using CUDACOMP may give one a false sense of security as the present method, although cumbersome, is done very carefully with people checking the output files to see if the numbers reflect the real world. A person might have a tendency not to do these types of checks when the process becomes automated.

10. **Walter Bourez, WRMI**

Bourez discussed different methods of simulating the San Joaquin reservoir systems. Some of the existing reservoir models are 15-20 years old and have not been updated for new hydrology. The existing process in DWRSIM is a "black box" approach to the analysis of San Joaquin drainage where that system is pre-operated. It is sought to remove the "black box" approach and provide a more realistic representation of that system as well as connecting the Delta Mendota Canal (DMC) to the San Joaquin Basin. At this point, the new system is in the preliminary stages and Bourez set a target date of 12-31-95 for readiness.

11. **Bill Smith, DWR**

Smith discussed public access to DWRSIM. At present, there is some documentation available for DWRSIM but there is no complete package. The new feature release of DWRSIM seeks to have a new output analysis system, a new job control input format, a merge of STANSIM, a new south of the delta schematic, a new SWP/CVP delivery logic, and a new San Joaquin River schematic. The other features (except for the San Joaquin River schematic) may be available in a few months.

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